
Pelagic seabird density and
vulnerability to oiling from the
Deepwater Horizon/MC-252 spill in
the Gulf of Mexico:
draft final report

PELAGIC BIRD SURVEYS
DEEPWATER HORIZON
(MC-252)

NATURAL RESOURCE
DAMAGE ASSESSMENT
(NRDA)

Bird Study No. 6

JAMES CHRISTOPHER HANEY, Ph.D.
Principal Investigator
Chief Scientist, Defenders of Wildlife

Revised 13 December 2011 from September 22, 2011

TABLE OF CONTENTS

Executive Summary	p. 4
Introduction	p. 5
Methods	p. 5
Results	p. 6
Deployment and coverage	p. 6
Observers and other personnel-related information	p. 6
Ships used for observer deployment	p. 6
Geographic coverage	p. 7
Study temporal effort and survey statistics	p. 8
Total survey effort	p. 8
Seasonal allocation of effort	p. 9
Relative effort across individual cruises	p. 9
Numbers and variety of pelagic birds recorded during the study	p. 11
Cumulative numbers of seabirds	p. 11
Species detected during study	p. 11
Relative abundances of seabirds tallied	p. 13
Visual observations of oiled seabirds	p. 13
Forensic photographs taken	p. 13
Numbers of photographs	p. 13
Quality and examples of photographs	p. 14
Status and disposition of all data collected under NRDA Bird Study #6	p. 15
Transect and station point count data sheets	p. 15
Forensic photographs	p. 16
Supplemental data available	p. 16
References	p. 16

Figure 1. Partial geographic coverage of surveys for marine birds as compiled under the auspices of NRDA Bird Study #6 in the Gulf of Mexico, 2010, shown in relation to the cumulative extent of the *Deepwater Horizon*/MC-252 oil spill. p. 7

Figure 2. Probabilities of oil transport risks from the *Deepwater Horizon*/MC-252 oil spill based on multiple runs of historical oceanographic current data and summarized for the entire Gulf of Mexico. p. 8

Figure 3. Comparison of seasonal coverage from four (4) historical formal, standardized surveys of pelagic birds conducted in the Gulf of Mexico. p. 9

Figure 4. Trace oiled (<5%) Sandwich Tern (*Thalasseus sandvicensis*) photographed aboard the NOAA vessel *Pisces*, July 2010, by G. Scott Mills. p. 14

Figure 5. Trace oiled (<5%) Sandwich Tern (*Thalasseus sandvicensis*) photographed aboard the NOAA vessel *Pisces*, July 2010, by G. Scott Mills. p. 15

Table 1. Summary of the total numbers, durations, and lengths (in kilometers) of all 300-meter, 10-minute strip transects and all point counts completed for NRDA Bird Study #6, July 2010 through July 2011. p. 10

Table 2. All seabird species observed during NRDA Bird Study #6 from ships-of-opportunity operating in the Gulf of Mexico in waters near and adjacent to the *Deepwater Horizon*/MC-252 oil spill. p. 12

Table 3. Summary of the numbers of digital photographs available for forensic screening of potential oiling on seabirds detected during pelagic surveys associated with NRDA Bird Study #6. p. 13

Appendix A: NOAA ship track coordinates

Appendix B: Survey effort by individual cruise and by individual cruise date in NRDA Bird Study #6

Appendix C: Effort by individual cruise and by individual cruise date for supplemental surveys conducted in the northern Caribbean Sea adjacent to the Gulf of Mexico

Appendix D: Breakdown of species and total numbers of seabirds by ship and cruise date during NRDA Bird Study #6

Appendix E: Photographic data base for NRDA Bird Study #6

Appendix F: Examples of satellite imagery, oceanographic summary, or other graphical compilations that were archived as part of NRDA Bird Study #6

EXECUTIVE SUMMARY

Natural Resource Damage Assessment (NRDA) Bird Study #6 was designed to estimate oiling rates among the offshore and pelagic marine birds inhabiting the Gulf of Mexico using ship-based surveys in the vicinity of the *Deepwater Horizon* (MSC 252) oil spill. A work plan for NRDA Bird Study #6 was finalized by the Trustee Pelagic Bird Technical Working Group on June 24, 2010 (Boyce et al. 2010). Study objectives were to: 1) Collect data describing the proportion of pelagic seabirds encountered along the ships path that were not visibly oiled, or that fell into pre-defined oiling categories; 2) Collect data to support an estimate of representative density of seabirds in offshore and pelagic waters in and adjacent to the spill zone; and 3) Document the location and state of any bird carcasses encountered along the ships' path. An instruction manual to train and educate pelagic bird observers was prepared separately to implement the methodologies and protocols prepared for meeting these study objectives (Haney 2010).

For achieving the first study objective in NRDA Bird Study #6, three different methods (including strip line transects, station point counts, and digital photographs) were combined. For the second study objective, strip line transects were the primary method employed. For the third study objective, i.e., location and state of bird carcasses along the ship's path, strip line transects and station point counts were used, but no observations of carcasses were collected. As far as is known, no bird carcasses were either observed or photographed by any of the observers deployed at sea during NRDA Bird Study #6.

A total of eight (8) observers on behalf of the Trustees, seven (7) independent contractors plus the principal investigator, were deployed on a total of seven (7) ships owned or operated by the National Oceanic and Atmospheric Administration (NOAA), U.S. Coast Guard, University National Oceanographic Laboratory System (UNOLS), and a private research support company. Surveys were conducted along the continental shelf of the eastern Gulf of Mexico from southwestern Florida to Louisiana and Texas down to the Mexican border, and north of an imaginary line drawn between the Texas-Mexico border and the Dry Tortugas of Florida. Relatively more shipboard effort was deployed in the eastern Gulf of Mexico, and within the north-central Gulf of Mexico.

Between 8 July 2010 and 17 July 2011, NRDA Bird Study #6 conducted 27 multi-day cruises or cruise legs totaling 285 partial or full days of sampling at sea. Cumulative length of these individual cruises or cruise legs varied between five (5) and nineteen (19) days. Surveys were conducted each calendar month except January; months with greater survey effort included April and May, and July through November 2010.

Within the Gulf of Mexico, a total of 5,665 strip line transects, with average duration of 10 minutes each, was collected during the study. Total duration of these transects was 950 hours, 16 minutes; cumulative length of these transects came to 15,322.4 kilometers. A total of 386 station point-counts of variable duration and summing to a total 341 hours, 26 minutes, were also collected. By the end of the study, more than 23,000 individual seabirds comprising 45 estuarine,

coastal, offshore, and pelagic species had been tallied. Average daily abundance of seabirds detected varied from a low of approximately 7 birds/day in November 2010 along regions of the mid- and outer continental shelf to a high of more than 580 birds/day in June 2011 within the near-shore, coastal waters of the northern Gulf. At least 1,524 digital photographs were secured for forensic examination of oiling rates, primarily from NOAA fisheries projects on which seabirds were attracted to significant by-catch resulting from trawl operations.

In addition to securing all data required to meet the objectives of NRDA Bird Study #6, various types of supplemental data were collected to assist in the interpretation and contextualization of the findings. These include various categories of environmental and oceanographic data that were not recorded on the standard data forms, including various types of satellite imagery, as well as the hourly ship cruise-track coordinates as recorded through NOAA's near real-time Ship Tracking System aboard those ships on which observers were deployed during NRDA Bird Study #6. This draft final report summarizes the conditions under which all these data were collected, and the disposition of all data collected and currently available for the NRDA.

INTRODUCTION

The *Deepwater Horizon* (DWH) blow out began on April 22, 2010. The largest accidental marine oil spill in the history of the petroleum industry, an estimated 206 million gallons of liquid petroleum and 500,000 tons of gaseous hydrocarbons ultimately escaped into the Gulf environment. These hydrocarbons and 1.84 million additional gallons of dispersant contaminated extensive portions of the water column and ocean surface in the Gulf of Mexico. Oil spill-related injury to wildlife is of major concern to the public and natural resource Trustees. Despite the apparently successful cap on the well that was accomplished on July 15, 2010, and a 'bottom kill' that transpired on September 19, 2010, both the original and any residual contaminants pose(d) potential ongoing risks to seabirds.

Distribution and density of birds at sea were estimated with aerial surveys (Bird Study #2), but oiled or dead birds cannot be routinely observed from the air. Moreover, some live birds cannot be readily identified to species from planes. To evaluate mortality and the proportion of live oiled birds in the pelagic zone, Bird Study #6 placed observers on ships-of-opportunity that were otherwise involved in sampling water quality, fish populations, marine mammals, or other natural resources in deep water in the vicinity of the spill and at locations where currents were likely to concentrate oil. Given what ultimately became the vast geographic extent to the cumulative spill zone, the at-sea observers also collected data for determining bird population densities at sea to complement the aerial survey data. Most importantly, pelagic surveys will help the Trustees more thoroughly scale the size, extent, and duration of the spill on marine bird resources – in time, in space, and in terms of the species and sizes of populations of seabirds that were vulnerable and exposed to oil in the marine realms of the Gulf.

This draft final report describes the data collected during Bird Study #6 but does not offer detailed analysis or interpretation of the data.

METHODS

All of the methods and protocols that were used for NRDA Bird Study #6, and the rationale and history behind the purpose for the study, were summarized by Boyce et al. (2010) and in Haney (2010). Therefore, those details are not repeated here in this Draft Final Report.

RESULTS

Deployment and coverage

Observers and other personnel-related information. NRDA Bird Study #6 used a total of eight (8) Trustee observers. Individuals independently contracted by the principal investigator for observer duty included: G. Scott Mills, Lisa T. Hug, E. Wayne Irvin, David S. Lee, Sarah L. Flaherty, Alex Wang, and Carol A. Keiper. On November 15, 2010, the RP formally withdrew as a cooperative participant in the study. Due to gender-specific berthing requirements, it was necessary to always have available observers of both genders ready for deployment. Due to simultaneous cruises, it was also necessary to have multiple observers available on relatively short notice. Each Trustee observer deployed had spent extensive time previously at sea counting marine birds, in the Atlantic and/or Pacific Oceans, and some had several decades of experience. None were novices to the demanding conditions involved during ship-board work. In addition, the principal investigator, J. Christopher Haney, also deployed to sea as an observer on occasion. Except for G. Scott Mills and Carol A. Keiper, each observer served on multiple deployments. Several individuals served for as long as months at a time.

Before deployment, all observers were required: 1) to sign a Department of Interior (DOI) confidentiality agreement, 2) to sign a contract with Defenders of Wildlife that required additional non-disclosure terms, 3) to be finger-printed and pass a NOAA security clearance (for NOAA ship duty), 4) to be medically-tested and –vaccinated in order to receive a NOAA medical clearance (for NOAA ship duty), and 5) to show proof of health insurance coverage (for U.S. Coast Guard and for UNOLS ship duty). In addition, and before the well was capped on 15 July 2010, some observers were required to receive respirator training in the event that air quality at sea during their deployment was below OSHA standards. Some observers, depending on their research work duties aboard NOAA ships, also received NOAA IT security training on-board.

Until September 2010, the Trustee observers were usually (but not always, depending on ship berthing availability, which was often in short supply) paired with an observer who represented the BP. The name(s) of the BP observers are listed on any data forms in which their participation occurred. It is worth noting that relationships between Trustee and BP observers were always cordial, and often enthusiastic. No problems were detected or reported to the principal investigator. In general, it would be fair to say that the expertise and prior training level of Trustee seabird observers were considerably higher on average than it was for the BP observers. Some Trustee observers remarked that the identification skills that are uniquely demanding for seabird observation were at the novice level in some BP observers. On some occasions, the BP observer could only record data, and did not attempt to identify birds.

The principal investigator will maintain indefinitely all of the hard and electronic files that relate to the confidentiality agreements, clearances, contracts, and other relevant background information on each Trustee observer. These records will also include very detailed expense and reimbursement reports for the observer travel and daily stipend. These records include: 1) the original signed contract, 2) a W-9 withholding form as independent contractor, 3) copies of all receipts and other travel documentation, 4) a spreadsheet of days worked, *per diem* eligibility, and receipt summary, and 5) a Defenders' check request for payment to the Trustee observer.

Ships used for observer deployment. The vast majority of deployments for NRDA Bird Study #6 were on ships owned and operated by NOAA. Most NOAA deployments were on ships associated with the National Marine Fisheries Service, Pascagoula, Mississippi. NOAA ships

used included the research vessels: *Pisces*, *Nancy Foster*, *Oregon II*, and *Gordon Gunter*. Except for the *Nancy Foster*, based in Charleston, South Carolina, each of the other NOAA ships is home-based in the Gulf of Mexico. In addition, Bird Study #6 deployed once on the U.S. Coast Guard cutter and buoy tender *Cypress*, based in Pensacola, Florida, a few times on the UNOLS research ship *F. G. Walton Smith*, based at the University of Miami, Miami, Florida, and once on the oil research support ship *Nick Skanski*, based or ported in Houma, Louisiana.

Ship deployment sometimes required observers to arrive into and then depart from different port cities. Departure from and return to Pascagoula, Mississippi, was the most frequent. However, at times observers also met arriving, or left on departing, ships from the following U.S. cities: Miami, Florida; Key West, Florida; Naples, Florida; Tampa/St. Petersburg, Florida; Pensacola, Florida; Mobile, Alabama; Houma, Louisiana; Galveston, Texas.

Geographic coverage. Spatial coverage by NRDA Bird Study #6 was extensive (**Figure 1**). In general, spatial coverage by the surveys in this study was more extensive and denser in the eastern and north-central Gulf of Mexico, with somewhat less coverage in the southwestern Gulf

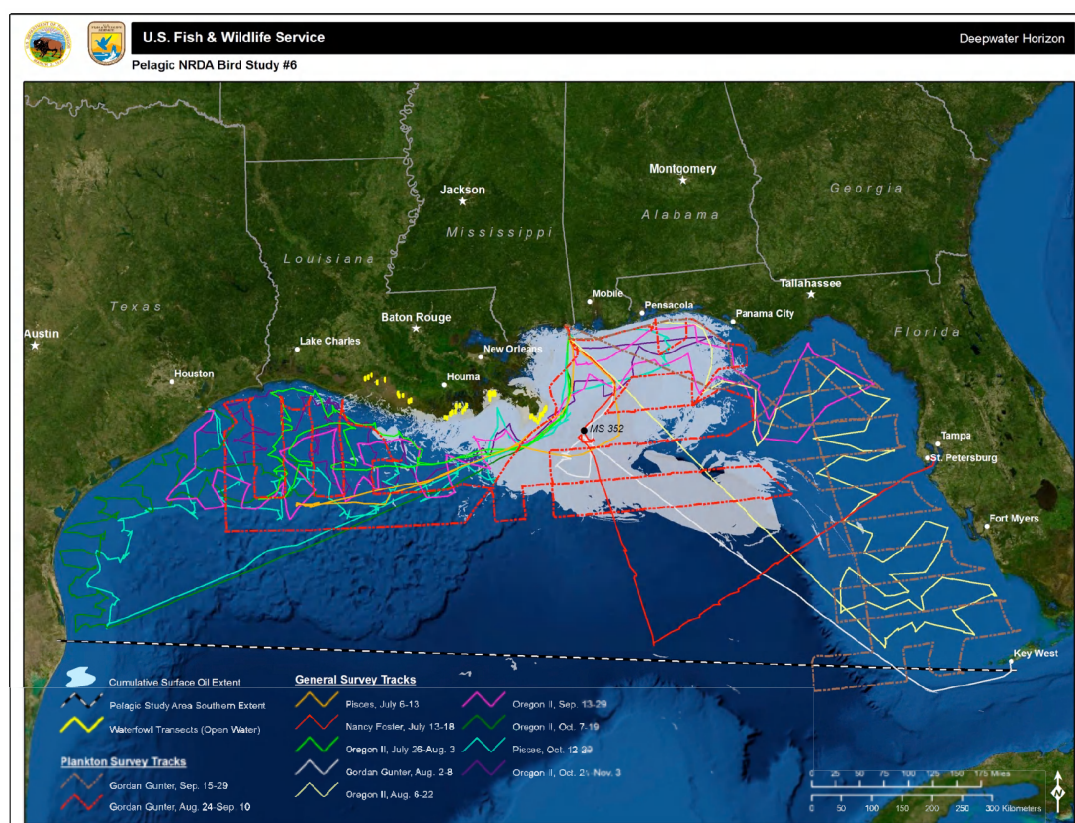


Figure 1. Partial geographic coverage of surveys for marine birds as compiled under the auspices of NRDA Bird Study #6 in the Gulf of Mexico, 2010, shown in relation to the cumulative extent of the *Deepwater Horizon*/MC-252 oil spill. Tracks depicted here reflect only the NOAA ship cruises that were conducted prior to early November 2010. Additional coverage, by other ships, and between November 2010 and July 2011, are not shown here.

and in the deepest portions beyond the edge of the continental shelf. In addition, ship-board coverage in NRDA Bird Study #6 tended to be highly-complementary (i.e., non overlapping) with the aerial surveys, and with the more coastal coverage typical of most other NRDA bird studies.

Regions surveyed included both continental shelf and deep pelagic habitats. Continental shelves of southern, central and eastern Texas, Louisiana, Mississippi, Alabama, and west Florida were all covered. Virtually all shelf habitats were sampled from just north and west of the Florida Keys to at least 96°W off central Texas. Deep water, pelagic habitats surveyed included the Loop Current, associated eddies and jets, continental slopes, the Desoto Canyon region off Alabama and northwest Florida, and the Mississippi Canyon areas at and immediately adjacent to the *Deepwater Horizon*/MC-252 well head.

As per protocol, geographic coordinates used throughout NRDA Bird Study #6 were recorded for the location of each of the strip line transects and the point station counts on the standard data forms used in this study. In addition, the hourly coordinates for most NOAA ship cruise tracks are provided as an electronic supplement, and as hard copy in **Appendix A**.

Geographic coverage of NRDA Bird Study #6 overlapped extensively both with the vicinity of the cumulative spill zone (**Figure 1**), and with prior and concurrent models that estimated the fate of oil spilled during the *Deepwater Horizon*/MC-252 event (**Figure 2**).

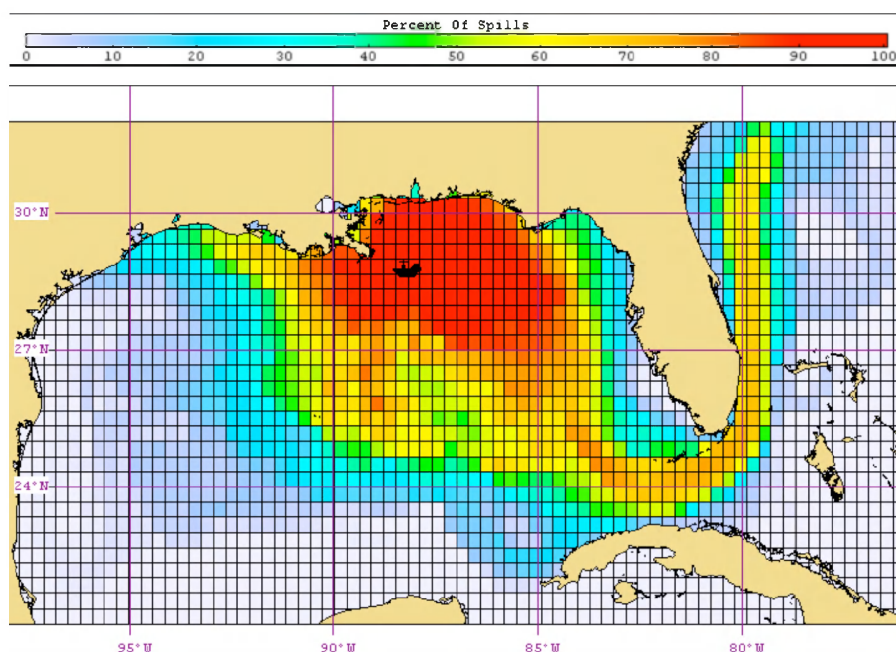


Figure 2. Probabilities of oil transport risks from the *Deepwater Horizon*/MC-252 oil spill based on multiple runs of historical oceanographic current data and summarized for the entire Gulf of Mexico. ([http://response.restoration.noaa.gov/topic_subtopic_entrv.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id&subtopic_id&entr_id\(entr_subtopic_topic\)=815&subtopic_id\(entr_subtopic_topic\)=2&topic_id\(entr_subtopic_topic\)=1](http://response.restoration.noaa.gov/topic_subtopic_entrv.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id&subtopic_id&entr_id(entr_subtopic_topic)=815&subtopic_id(entr_subtopic_topic)=2&topic_id(entr_subtopic_topic)=1)). The higher the percent of spills displayed here, the greater the risk that a geographic cell would experience contamination from the *Deepwater Horizon*/MC-252 event.

Study temporal effort and survey statistics

Total survey effort. In total, and within a bit more than a 365-day period, Trustee observers spent 285 days actively surveying the Gulf's coastal, offshore, and pelagic waters for marine birds. This total daily effort reflects the at-sea component of the study *only*, and does not include the total number of contracted or project days.

Seasonal allocation of effort. Seasonal coverage by NRDA Bird Study #6 was also very extensive (Figure 3). Between July 2010 and July 2011, the study conducted surveys every month except January. The prolonged duration of Bird Study #6 will enable some assessment of pelagic bird density and oiling more than a full year after the *Deepwater Horizon*/MC-252 spill started, as well as providing comparison data for the status of marine birds from those months/seasons in which the spill was actively occurring (April, May, June, July).

Surveys were conducted each calendar month except for January, when most research ships are docked for routine annual maintenance. Months with the greatest survey effort in NRDA Bird Study #6 included April and May, and July through November. NRDA Bird Study #6 was the first-ever standardized, formal pelagic bird study conducted in the Gulf of Mexico to survey during the months of March and July.

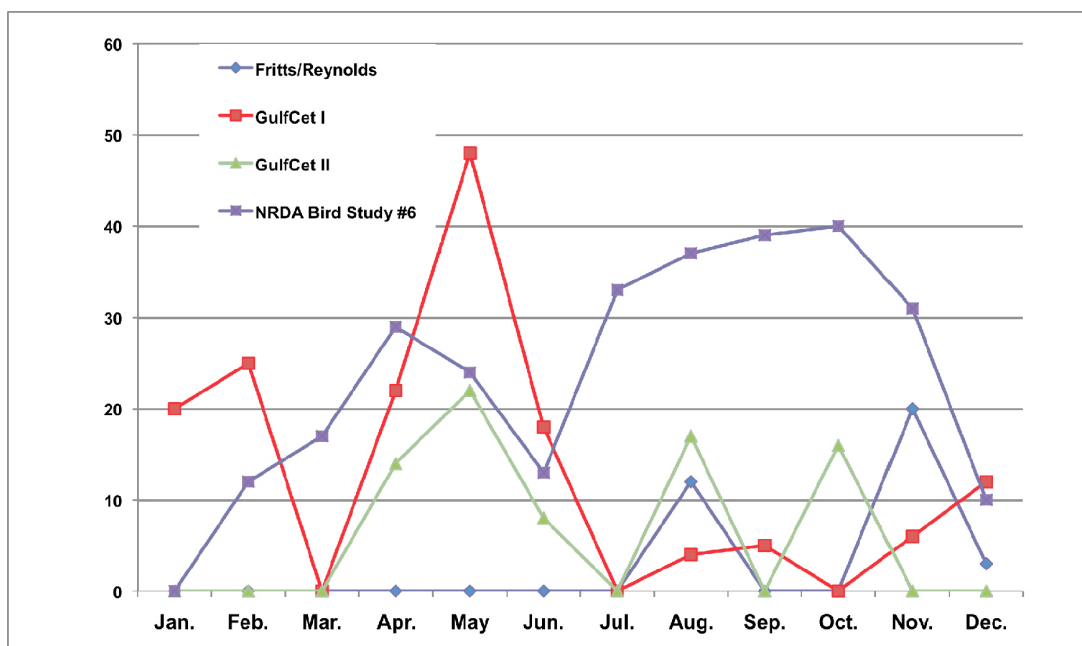


Figure 3. Comparison of the seasonal coverage (vertical axis in days) from four (4) different formal, standardized surveys of pelagic birds conducted in the Gulf of Mexico. NRDA Bird Study #6 refers to the study summarized in this Draft Final Report. The study by Fritts and Reynolds (1981) was an aerial survey carried out in the far eastern and far western Gulf. The GulfCet I and GulfCet II surveys, in the northwestern and northeastern Gulf, were aimed primarily at research on marine mammals and their habitats, but bird surveys were also conducted opportunistically (e.g., see Davis and Fargion 1996).

Figure 3 also demonstrates that the seasonal density of coverage during the fall and late winter/early spring months was greatly increased over the previous studies. The amount of coverage for fall in particular more than doubled that over all previous Gulf studies of pelagic birds combined. The duration and relatively dense seasonal coverage from NRDA Bird Study #6 reduces considerably the gaps that might otherwise obscure a more robust assessment of the scope and scale of injury to the marine bird community in the months following the spill.

Relative effort across individual cruises. A total of 27 cruise or cruise legs (at-sea deployments interrupted by one or more port calls) were conducted during NRDA Bird Study #6. Cumulative length of a particular individual cruise or cruise leg could vary anywhere between five (5) and nineteen (19) days. Totals for the number of transects, duration of transects, length of transects, number of point counts, and duration of point counts for each of the cruise dates are all summarized below in **Table 1**, and displayed in more detail by individual cruise and by

individual day in **Appendix B**. Summary statistics in **Appendix B** pertain to those parts of cruises that were conducted only within the Gulf of Mexico proper.

Effort summaries for supplemental surveys conducted as parts of two cruise legs conducted outside the Gulf of Mexico proper are given separately in **Appendix C**. These two research legs (each associated with NOAA's spring, two-month long ichthyoplankton survey for bluefin tuna larvae) sampled extensively in the northern Caribbean Sea adjacent to the Gulf of Mexico. A total of 494 strip transects and 15 station point counts were carried out between 28 March 2011 and 26 April 2011 in the northern Caribbean Sea. It was not practical or even possible to place or to remove observers for the Gulf-only portions. Instead, the observers remained on the ship and continued to make observations of seabirds in both regions; these data are not included here.

Table 1. Summary of the total numbers, durations, and lengths (in kilometers) of all 300-meter, 10-minute strip transects and all point counts completed for NRDA Bird Study #6, July 2010 through July 2011.

<i>Cruise</i>	<i>Number of transects</i>	<i>Total duration of transects (hr:min)</i>	<i>Total length of transects (km)</i>	<i>Number of point counts</i>	<i>Total duration of point counts (hr:min)</i>
8-12 July 2010	44	7:20	128.8	16	30:27
13-18 July 2010	128	21:20	380.2	4	4:15
26 July-2 August 2010	346	57:40	865.5	1	0:25
2-7 August 2010	140	23:20	380.9	7	6:45
7-21 August 2010	327	56:37	1,011.2	26	18:38
21-26 August 2010	35	2:40	119.4	10	47:33
24 August-9 September 2010	374	62:26	1,098.3	28	19:29
13-28 September 2010	169	28:50	474.1	41	40:41
15-28 September 2010	289	48:10	840.7	14	7:00
8-18 October 2010	255	42:30	641.1	0	0:00
13-28 October 2010	255	42:40	682.5	29	21:55
21 October-3 November 2010	252	42:00	550.7	0	0:00
2-12 November 2010	205	34:10	515.4	19	12:08
9-19 November 2010	227	37:50	636.5	0	0:00
16-22 November 2010	138	23:00	295.4	17	5:46
3-14 December 2010	212	35:20	508.7	2	0:56
17 Feb-1 March 2011	217	36:10	589.2	41	18:30
10-22 March 2011	295	49:20	857.0	27	14:30
24-27 March 2011	130	21:40	307.7	1	0:10
7-25 April 2011	122	20:20	329.5	41	71:33
24-28 April 2011	114	19:00	292.7	3	1:30
25-30 April 2011	166	27:40	481.0	3	2:15
2-10 May 2011	279	46:30	724.1	2	1:40
13-27 May 2011	464	77:20	1,153.7	0	0:00
7-11 June 2011	91	16:53	319.8	5	3:00
23 June-4 July 2011	191	36:00	568.9	41	9:00
6-17 July 2011	200	33:30	569.4	18	3:20
GRAND TOTAL	5,665	950:16	15,322.4	386	341:26

Numbers and variety of pelagic birds recorded during the study

Cumulative numbers of seabirds. Counting all birds, including those both within and beyond the 300-m width strip line transect limit, all the point station-counts, and on any and all data forms, NRDA Bird Study #6 detected a grand tally of more than 23,000 individual birds across all cruises (**Table 2**). The total from NRDA Bird Study #6 is almost three (3) times more individual birds than recorded in the GulfCet II pelagic surveys (8,507 individual birds), more than eight (8) times more birds than recorded in the GulfCet I pelagic surveys (2,692 individual birds), and more than eleven (11) times more birds than recorded during the Fritts and Reynolds (1981) aerial surveys (1,946 individual birds). Thus, the total numbers of individual seabirds recorded during NRDA Bird Study #6 exceeded the combined total of all previous standardized, formal seabird studies ever conducted in the Gulf of Mexico.

Species detected during study. At least 45 species of estuarine, coastal, offshore, and pelagic birds were detected during the entirety of NRDA Bird Study #6 (**Table 2**). Forty-two of these species had been identified in the original study plan (Boyce et al. 2010) and/or instruction manual (Haney 2010) as previously occurring or likely to occur in offshore waters of the Gulf of Mexico based on a literature review. That list consisted of species that were expected to occur across all seasons. A more detailed breakdown of the species observed on each individual cruise is provided in **Appendix D**.

Bird Study #6 detected almost 92% of the species that were originally anticipated and compiled prior to the launch of the study. Species in that original list that were *not* detected anytime during the pelagic surveys included: Pied-billed Grebe (*Podilymbus podiceps*), Yellow-nosed Albatross (*Thalassarche chlororhynchos*), Manx Shearwater (*Puffinus puffinus*), Red-footed Booby (*Sula sula*), Sabine's Gull (*Xema sabini*), Arctic Tern (*Sterna paradisaea*), and Black Skimmer (*Rhynchops niger*). The first and last species are not typically seen in the deep, pelagic marine waters of the Gulf of Mexico; the other species are either exceedingly uncommon or actually accidental in the Gulf of Mexico. Manx Shearwater is known to have occurred in the Gulf during the time of the spill; at least six (6) dead oiled and un-oiled individuals of this species are reported in the Bird Impact Data from the DOI-ERDC NRDA Database, dated 12 May 2011 (see <http://www.fws.gov/home/dhoilspill/collectionreports.html>; accessed 13 September 2011).

Species not originally anticipated prior to NRDA Bird Study #6 but nevertheless detected included: Black Scoter (*Melanitta americana*), other sea duck species, Neotropic Cormorant (*Phalacrocorax brasilianus*), and White Pelican (*Pelecanus erythrorhynchos*). Although expected to occur widely in the Gulf of Mexico, all of these species are typically found in more nearshore or estuarine waters.

Despite some notable seasonal differences in composition of the marine bird community in the Gulf of Mexico, the annualized composition of seabirds recorded in this study tended to be strongly dominated by larids. More than 75% of all individual seabirds recorded across the study were gulls, terns, and/or jaegers/skuas. The next most dominant group was the pelicaniformes (boobies, pelicans, etc.), with 18% of all individual seabirds. The procellariiformes, or tube-nosed birds (e.g., shearwaters, storm-petrels), comprised less than 4% of all seabirds detected during the study.

Observers sometimes made notations of terrestrial, non-aquatic bird species that were observed during station point counts and/or transect surveys. These data are not included in this report.

Table 2. All seabird species observed during NRDA Bird Study #6 from ships-of-opportunity operating in the Gulf of Mexico in waters near and adjacent to the *Deepwater Horizon*/MC-252 oil spill. Other aquatic species, such as herons and osprey, and all terrestrial species that were seen flying over the ocean are not included in this table. Nomenclature here follows A.O.U. (2011; see <http://www.aou.org/checklist/north/>, accessed 12 September 2011). Numbers in column two are the approximate minimum due to using the lowest number when observers reported individual birds in units of “tens” or “hundreds,” especially outside the 300 m transect.

Common Name	Scientific Name	Approximate minimum total number recorded
Black Scoter	<i>Melanitta americana</i>	1
sea duck sp.	n/a	447
Common Loon	<i>Gavia immer</i>	51
Horned Grebe	<i>Podiceps auritus</i>	108
Black-capped Petrel	<i>Pterodroma hasitata</i>	8
<i>Pterodroma</i> sp.	<i>Pterodroma</i> sp.	1
Cory's Shearwater	<i>Calonectris diomedea</i>	61
Great Shearwater	<i>Puffinus gravis</i>	66
Sooty Shearwater	<i>Puffinus griseus</i>	1
Audubon's Shearwater	<i>Puffinus lherminieri</i>	585
shearwater sp.	<i>Puffinus</i> sp.	28
Wilson's Storm-Petrel	<i>Oceanites oceanicus</i>	27
Leach's Storm-Petrel	<i>Oceanodroma leucorhoa</i>	2
Band-rumped Storm-Petrel	<i>Oceanodroma castro</i>	35
storm-petrel sp.	<i>Oceanodroma</i> sp.	5
White-tailed Tropicbird	<i>Phaethon lepturus</i>	1
Red-billed Tropicbird	<i>Phaethon aethereus</i>	5
tropicbird species	<i>Phaethon</i> sp.	2
Magnificent Frigatebird	<i>Fregata magnificens</i>	344
Masked Booby	<i>Sula dactylatra</i>	35
Brown Booby	<i>Sula leucogaster</i>	7
ulid sp.	<i>Sula</i> sp.	5
Northern Gannet	<i>Morus bassanus</i>	1,026
Neotropic Cormorant	<i>Phalacrocorax brasilianus</i>	6
Double-crested Cormorant	<i>Phalacrocorax auritus</i>	100
White Pelican	<i>Pelecanus erythrorhynchos</i>	1
Brown Pelican	<i>Pelecanus occidentalis</i>	2,693
<i>Phalaropus</i> sp.	<i>Phalaropus</i> sp.	56
Red-necked Phalarope	<i>Phalaropus lobatus</i>	21
Red Phalarope	<i>Phalaropus fulicarius</i>	1
Bonaparte's Gull	<i>Chroicocephalus philadelphia</i>	90
Laughing Gull	<i>Leucophaeus atricilla</i>	6,772
Franklin's Gull	<i>Leucophaeus pipixcan</i>	1
Ring-billed Gull	<i>Larus delawarensis</i>	15
Herring Gull	<i>Larus argentatus</i>	1,531
Great Black-backed Gull	<i>Larus marinus</i>	2
gull sp.	<i>Larus</i> sp.	141
Brown Noddy	<i>Anous stolidus</i>	16
Sooty Tern	<i>Onychoprion fuscatus</i>	871
Bridled Tern	<i>Onychoprion anaethetus</i>	86
Sooty/Bridled-type terns	<i>Onychoprion</i> sp.	36
Least Tern	<i>Sternula antillarum</i>	23
Gull-billed Tern	<i>Gelochelidon nilotica</i>	18
Caspian Tern	<i>Hydroprogne caspia</i>	4
Black Tern	<i>Chlidonias niger</i>	2,323
Roseate Tern	<i>Sterna dougallii</i>	2
Common Tern	<i>Sterna hirundo</i>	1,905
Forster's Tern	<i>Sterna forsteri</i>	31
Royal Tern	<i>Thalasseus maximus</i>	1,785

Sandwich Tern	<i>Thalasseus sandvicensis</i>	1,415
tern sp.	Tern sp.	489
South Polar Skua	<i>Stercorarius maccormicki</i>	1
skua/large dark jaeger	<i>Stercorarius</i> sp.	2
small jaeger	<i>Stercorarius</i> sp.	10
Pomarine Jaeger	<i>Stercorarius pomarinus</i>	79
Parasitic Jaeger	<i>Stercorarius parasiticus</i>	18
Long-tailed Jaeger	<i>Stercorarius longicaudus</i>	2
	TOTAL SPECIES = 45+	TOTAL INDIVIDUALS = 23,397

Relative abundances of seabirds tallied. Daily relative abundance of birds detected during NRDA Bird Study #6 could vary widely, depending on location, season, and the ship's research activities. Average daily abundance of seabirds detected varied from a low of approximately 7 birds/day in November 2010 along regions of the mid- and outer continental shelf to a high of more than 580 birds/day in June 2011 within the near-shore, coastal waters of the northern Gulf.

As expected in the Gulf of Mexico, there were locations and seasons where pelagic densities were extremely low. It was not unusual for observers on occasion to go for an entire day without seeing any birds at all, especially far offshore on the middle and outer continental shelf, or in very deep waters far from any edges of the Loop Current or other prominent oceanographic features. Locations and/or times when especially low (i.e., <20 birds/day) relative abundances were recorded by the study included: 8-12 July 2010 from the R/V *Pisces* in the north-central Gulf of Mexico near and west of the Mississippi River delta; 13-18 July 2010 from the R/V *Nancy Foster* off the west Florida continental shelf and at or near the Loop Current's "Eddy Franklin"; 13-28 October, 2-12 November, and 16-22 November 2010, all from the R/V *Pisces* along the outer continental shelf.

Locations and/or times when especially high (i.e., >200 birds/day) relative abundances were recorded by the study included: 7-11 June and 23 June-4 July 2011 from the R/V *Oregon II* along the inner continental shelf. Both of these cruises were engaged in fisheries trawls with significant by-catch, which tended to attract and retain seabirds near the survey platform.

Visual observations of oiled seabirds. Nine individual seabirds were visually detected by observers as having oil, eight in the trace and one in the light category. Locations for visually oiled birds ranged from off eastern Texas to north of the Florida Keys. Species detected visually as having oil included Magnificent Frigatebird, Laughing Gull, Sooty Tern, and Sandwich Tern.

Forensic photographs taken

Numbers of photographs. At least 1,524 digital photographs using the USFWS-issued cameras were secured for forensic examination and analysis of oiling rates (**Table 2**; a more detailed breakdown of the file names, dates, times, ship, content, and observer for each photograph is provided in **Appendix E**). By far, the largest number of photographs was obtained primarily from

Table 3. Summary of the numbers of digital photographs available for forensic screening of potential oiling on seabirds detected during pelagic surveys associated with NRDA Bird Study #6.

Cruise dates	Observer	Ship name	Total number of photographs
July 26 – August 2, 2010	Lisa T. Hug	NOAA R/V <i>Oregon II</i>	11
October 7 – 19, 2010	Alex Wang	NOAA R/V <i>Oregon II</i>	240
October 19 – November 3, 2010	Alex Wang	NOAA R/V <i>Oregon II</i>	335
November 19, 2010	Sarah L. Flaherty	NOAA R/V <i>Pisces</i>	146
December 2 –16, 2010	Alex Wang	UNOLS R/V <i>F.G. Walton Smith</i>	151

June 23 – July 17, 2011	David S. Lee	NOAA R/V <i>Oregon II</i>	641
		<i>TOTAL photographs</i>	1,524

those NOAA fisheries projects on which significant trawl by-catch had occurred. The by-catch discards recruited and then retained larger numbers of seabirds in close proximity to the ships. Many birds stayed with the ship for hours or even days, and some birds roosted on the deck and superstructure, thereby making photographic records easier to obtain.

Photographs are referenced to individual survey transects by the time they were taken. Some photograph numbers are also noted on data forms. Collection and handling of photographic evidence during NRDA Bird Study #6 was incorporated in a SOP dated August 1, 2010 and that covered shipping, handling, and chain-of-custody forms for electronic devices. No SOP has been developed for how to analyze the photographs, including the count methods for determining the number of birds oiled.

Quality and examples of photographs. Most individual seabirds detected by naked eye or through binoculars during pelagic surveys could not be reliably determined as oiled or not. To illustrate, on the 8-12 July 2010 cruise of the R/V *Pisces*, for at least 61 of the 81 total individuals recorded (i.e., 75%), the naked eye was not always able to detect the presence of oiling, even with two observers. Photographs were found to be far more reliable, however, for determining oiling status, even when oiling status was not obvious at the time the photograph was actually taken.

To illustrate, G. Scott Mills (Trustee observer) took the following two pictures of an oiled Sandwich Tern with his personal camera (**Figures 4, 5**). The location was about 150-180 km north of the *Deepwater Horizon*/MC-252 well-head.



Figure 4. Trace oiled (<5%) Sandwich Tern (*Thalasseus sandvicensis*) photographed aboard the NOAA vessel *Pisces*, 8 July 2010, by G. Scott Mills. Note inconspicuous oil smudges.

When Scott took each picture, and tracking the bird through the viewfinder of his personal camera, he did *not* suspect that the bird was then oiled. Indeed, he was taking what he thought

would turn out to be a normal bird that might serve as a good reference or benchmark when and if oiling was detected subsequently. Oil exposure on some individual seabirds is extremely difficult to detect under typical field conditions. Such bias will tend to greatly under-estimate the true extent of direct oil exposure that was experienced by marine birds in the Gulf of Mexico from the *Deepwater Horizon*/MC-252 spill.



Figure 5. Trace oiled (<5%) Sandwich Tern (*Thalasseus sandvicensis*) photographed aboard the NOAA vessel *Pisces*, 8 July 2010, by G. Scott Mills. Note the very inconspicuous placement of oil on the axillary region of the under wing, probably acquired while the bird was plunge diving through sheen.

Status and disposition of all data collected as part of NRDA Bird Study #6

Required deliverables from NRDA Bird Study #6 include all of the original data sheets used for recording the pelagic surveys, and the digital photographs that depict any oiling on seabirds. No analysis or interpretation of these two primary data types was required under terms of this contract.

Transect and station point count data sheets. At least three complete copies of the data forms exist. The original set of data sheets was submitted to the NRDA-USFWS office in Fairhope, Alabama, with the last set of hard copy from the last cruise delivered in person by the principal investigator on July 18, 2011. A second complete digital set of these transect and/or station point count data sheets were scanned onto the NRDA-issued laptops as per protocol during surveys aboard ships; these were also returned to and now reside with the NRDA-USFWS office in Fairhope, Alabama. A third, complete set of data forms in hard copy format is housed with the principal investigator at: Defenders, of Wildlife, 1130 17th Street, NW, Washington, DC 20036.

Beginning in February 2011, the original data forms were entered into the permanent archive and QA/QC- certified through the Department of the Interior's Deepwater Horizon (MC252) NRDA Database, created and maintained jointly by the DOI the U.S. Army Corps of Engineers Engineer

Research and Development Center (ERDC)(a.k.a. the ERDC Database). However, I estimate that on the order of only about 40% of all data forms have been QA/QC-certified as of the date on this draft final report. All eight observers have been notified that they are to expect questions from the ERDC Database about missing or incomplete information, and to answer those questions expeditiously.

Forensic photographs. At least two complete copies exist of all digital photographs. The original digital files were submitted to the NRDA-USFWS office in Fairhope, Alabama, as per protocol used in the study. A second copy of all digital photographs, sent by the NRDA-USFWS office in Fairhope, Alabama to the principal investigator in August 2011 in order to create the electronic photographic database/archive, remains in the possession of the principal investigator at: Defenders, of Wildlife, 1130 17th Street, NW, Washington, DC 20036.

Supplemental data available. Various types of supplemental data that were not expressly required by the terms of the contract are nevertheless available, and these are either included or referenced within this report. These include: 1) **Appendix A**, an itemized summary of most (but not all) of the NOAA ship cruise track coordinates (172 total pages); 2) **Appendix B**, the daily break-out of sampling effort, with a separate table provided for each of the 27 cruise or cruise legs conducted within the Gulf of Mexico (9 total pages); 3) **Appendix C**, the daily break-out of sampling for each of two cruises or cruise legs conducted in the northern Caribbean Sea (1 total page); 4) **Appendix D**, the breakdown of species and total numbers of seabirds by ship and cruise date during the entirety of NRDA Bird Study #6 (3 total pages), 5) **Appendix E**, the photographic data base/archive (64 total pages), and 6) **Appendix F**, examples of types of oceanographic data and/or satellite imagery that were collected during NRDA Bird Study #6, and that are supplied in full in electronic format only (8 total pages).

Not included in any portion of the hard copy of this draft final report, the various Appendices, or on the electronic supplement (flash drive) is the list of species and individual totals for seabirds recorded in the northern Caribbean Sea, the contract and reimbursement information for NRDA Bird Study #6, the final costs and expenses, and other administrative information.

REFERENCES

- Boyce, J., V. Byrd, V. Varela, S. Allen, L. Balance, C. Beidleman, J. Browder, G. Ford, C. Haney, C. Hunter, C. Jeske, K. Kuletz, B. Ortego, and J. Wheeler. 2010. Work plan for estimating oiling rates among pelagic birds using ship based surveys in the vicinity of the *Deepwater Horizon* (MSC 252) oil spill (Bird Study #6). 15 pp.
- Davis, R.W., and G.S. Fargion, editors. 1996. Distribution and abundance of cetaceans in the north-central and western Gulf of Mexico: Final Report. Volume II: Technical Report. OCS Study MMS 96-0027. Prepared by the Texas Institute of Oceanography and the National Marine Fisheries Service. U.S. Dept. of the Interior, Minerals Mgmt. Service, Gulf of Mexico OCS Region, New Orleans, LA. 357 pp.
- Fritts, T.H., and R.P. Reynolds. 1981. Pilot study of the marine mammals, birds and turtles in OCS areas of the Gulf of Mexico. Rept. FWS/OBS-81/36. U.S. Fish and Wildlife Service, Division of Biological Services, Washington, D.C. 140 pp.
- Haney, J. C. 2010. Instruction and reference manual: pelagic bird surveys, *Deepwater Horizon* (MC-252), Natural Resource Damage Assessment and Restoration Bird Study #6. 37 pp.